

## SPREAD SPECTRUM CELLULAR HANDOFF METHOD

### RELATED PATENTS

This patent is a continuation-in-part of a patent application entitled, **SPREAD SPECTRUM METHOD**, having Ser. No. 07/703,095, and Filing Date of May 22, 1991.

### BACKGROUND OF THE INVENTION

This invention relates to a code division multiple access (CDMA) spread spectrum system, and more particularly to a method for handing off communications between two or more microcells in a personal communications network.

### DESCRIPTION OF THE PRIOR ART

While prior art CDMA spread spectrum systems, such as one being developed by QUALCOMM, use time synchronization, the design is not very sensitive to how accurately this is done. Basically the chip codewords are randomized so that the radio receiving the transmitted signal using chip codeword,  $x$ , experiences the equivalent noise variance,  $N_1$ , due to  $M-1$  interference signals as

$$N_1 = (M-1)L$$

and the total sum of such noise variance terms among all radios is

$$\sum_{m=1}^M N_m = ML(M-1)$$

For the case  $M=L$  this results in non-zero interference compared to the use of orthogonal codewords which give zero interference. Such a prior art system clearly is not optimum for the case where  $M=L$ . For  $M \gg L$ , however, the difference between the prior art system interference and the lower bound given by Welch (1974) is quite small.

In their cellular radio system QUALCOMM assumes that the number of users  $M$  is much larger than the code length  $L$  and, to overcome the interference, they use strong error correction coding that gives 5 dB of coding gain and voice activation which accounts for an additional 5 dB. Together this is about 10 dB of gain.

Because the cellular cells are quite large, there are typically multipath signals with delay differences larger than a chip time interval. QUALCOMM, apparently uses an adaptive RAKE type receiver that coherently combines multipath components. This improves the overall performance for the cellular radios.

### OBJECTS OF THE INVENTION

A general object of the invention is a high capacity microcell using spread spectrum modulation.

An object of the present invention is a method for handing off communications of a remote unit traversing between two microcells using spread spectrum modulation in a personal communications network.

Another object of the present invention is a CDMA spread spectrum communications system which does not lose communications while a remote unit traverses between two microcells.

A further object of the present invention is a method for handing off communications of a remote unit tra-

versing between two microcells in a CDMA spread spectrum communications system which takes advantage of orthogonal chip codewords which have a cross correlation of zero.

### SUMMARY OF THE INVENTION

According to the present invention, as embodied and broadly described herein, a method is provided for handing off a transitioning-remote unit traversing from a first microcell to a second microcell. The first microcell has a first base station communicating with a first plurality of remote units. The transitioning-remote unit is assumed initially to be included among the first plurality of remote units. The second microcell has a second base station communicating with a second plurality of remote units. The first base station communicates to the first plurality of remote units with a first plurality of base-communications signals, respectively, using synchronous, code division multiple access, i.e. direct sequence spread spectrum modulation, at a first carrier frequency and a first power level. The first base station optionally may communicate simultaneously to a third plurality of remote units with a third plurality of base-communications signals using synchronous, code division multiple access at a second carrier frequency and a second power level. The second power level optionally may be greater than the first power level.

The second base station communicates simultaneously to the second plurality of remote units with a second plurality of base-communication signals using synchronous, code division multiple access at the second carrier frequency and the first power level. The second base station optionally may communicate simultaneously with the fourth plurality of remote units with a fourth plurality of base-communications signals using synchronous, code division multiple access at the first carrier frequency and at the second power level.

While the transitioning-remote unit traverses from first microcell to the second microcell, the second base station detects, exceeding a predetermined threshold, the power level of the remote-communications signal transmitted from the transitioning-remote unit. The second base station communicates, using a signalling channel, to the first base station to handoff the transitioning-remote unit from the first base station. The signalling tells the transitioning-remote unit to change operating frequency to the second carrier frequency and provides a new chip codeword, i.e. a transitioning-chip codeword. The transitioning-remote unit subsequently accesses, using an access protocol, the second base station at the second carrier frequency with the second transitioning-chip codeword. The transitioning-remote unit accordingly communicates with the second base station.

Additional objects and advantages of the invention will be set forth in part in the description in part which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention also may be realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

### BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings which are incorporated in and constitute a part of this specification, illustrate particular embodiments of the invention, and together